

inches was recorded. During the first 72 hours of the month of July 14.06 inches of rain fell in this vicinity.

The greatest 24-hour fall during that time was 8.36 inches from 6:30 a. m. on the 3d to 6:30 a. m. on the 4th. Of that, 3.55 inches fell from 6:30 a. m. to 6:30 p. m. on the 3d, and 4.81 inches fell during the night that followed.

The heaviest previous 24-hour rainfall since October, 1917, was on January 23, 1919, when a total precipitation of 2.23 inches was recorded. Our highest record in any month was 5.95 inches, during August, 1918.

There has been very little rainfall in this region during the past two years. I have no complete record for the year 1917, but the precipitation during the year 1918 was only 19.53 inches, with a total of 77 days upon which 0.01 inch or more fell. The 1918 precipitation is very likely a minimum record for several years in this vicinity, as I am of the opinion that the normal rainfall for Tampico and northern Vera Cruz is at least two or three times more than 19.53 inches. I also believe that the precipitation on July 3 of this year is a maximum 24-hour record for several years.

As may be seen from the data given below, this last excessive rain came from the east and northeast, and there was no break until the wind went to the west.

Meteorological record at Tampico, Mexico, June 29 to July 5, 1919.

[Observations at 6:30 a. m. (Tampico time) on dates given.]

| Date. | Temperature. | | | Pressure. | | State of weather. | Wind from. | Other observations. |
|------------|--------------|------|-------|-----------|-------|-------------------|------------|---------------------|
| | Max. | Min. | Mean. | Max. | Min. | | | |
| June 30... | 90.5 | 79.5 | 85.0 | 29.88 | 29.82 | cldy. | se. | 0.14 in. rain. |
| July 1... | 88.5 | 73.5 | 81.0 | 29.92 | 29.84 | cldy. | sw. | 0.98 in. rain. |
| 2... | 83.0 | 72.0 | 77.5 | 29.93 | 29.85 | cldy.-rain. | ne. | 2.88 in. rain. |
| 3... | 79.0 | 72.0 | 75.5 | 29.85 | 29.81 | cldy. | e. | 2.82 in. rain. |
| 4... | 77.0 | 71.5 | 74.3 | 29.86 | 29.80 | cldy. | ne. | 8.36 in. rain. |
| 5... | 79.5 | 72.5 | 76.0 | 29.90 | 29.80 | cldy. | sw. | 0.46 in. rain. |
| 6... | 87.0 | 73.0 | 80.0 | 29.92 | 29.88 | cldy. | w. | 0.00 in. rain. |

Total rainfall this week.....inches.. 15.64
Total rainfall this month to date.....do..... 14.5
Total rainfall this year to date.....do..... 27.26

NOTE.—The above pressure data are shown as recorded by our recording barometer; the temperature as shown by standard maximum and minimum thermometers; and the rainfall as measured in a common rain gage.

NORTHERS ON THE EAST COAST OF MEXICO, THEIR EFFECTS, AND FORECAST BY LOCAL OBSERVATIONS.

By S. A. GROGAN.

[Dated Tampico, Mexico, July 9, 1919.]

With the exception of the tropical storms during the summer months, there is no other weather which causes more concern among the navigators on the Gulf of Mexico than do the northers along the east coast of Mexico from about the 1st of September to the latter part of April. From September, 1918, to June, 1919, 31 northers visited Tampico.

Few records show of any ships being lost in the open sea from the effects of these north winds, but many have suffered serious damage or have been entirely lost from being blown up on the coast or the breakwaters at the entrances to the ports. No records have been obtained previous to 1917, but during that year there were seven disasters in the vicinity of Tampico, which can be attributed to northers.

Mr. Wm. J. Pulford, Lloyd's agent at Tampico, has been so kind as to furnish me with the following list of disasters for that year:

March 18, American tanker *Winnifred* went ashore south Tampico breakwater. Refloated on March 23 and towed to the United States for repairs.

May 17, American barge *Vaska* went ashore and lost north of Tampico breakwater.

October 20, American schooner *El Gallo* went ashore south of Tampico. Became a total loss.

October 30, American tug *Southbay* foundered outside Tampico breakwater.

October 31, American tanker *Paddleford* driven ashore south Tampico breakwater. Floated the following spring and taken to the United States for repairs.

November 15, American tug *Relief* went ashore north of Tampico. Floated on November 17.

December 8, American steamer *Wellington* drifted ashore in heavy norther. Sustained general damage to hull, rudder, etc.

While no lives were lost in any of the above disasters they occurred at a time when there was a general demand for more ships. Of the above, the tanker *Paddleford* was probably the greatest loss. Although it was floated in the following spring, it was taken from its important duty of conveying oil to the United States during the time it laid up on the breakwater and it was being repaired in the States.

During the first part of the year 1918 the schooner *Veracruz* was blown ashore on the south breakwater.

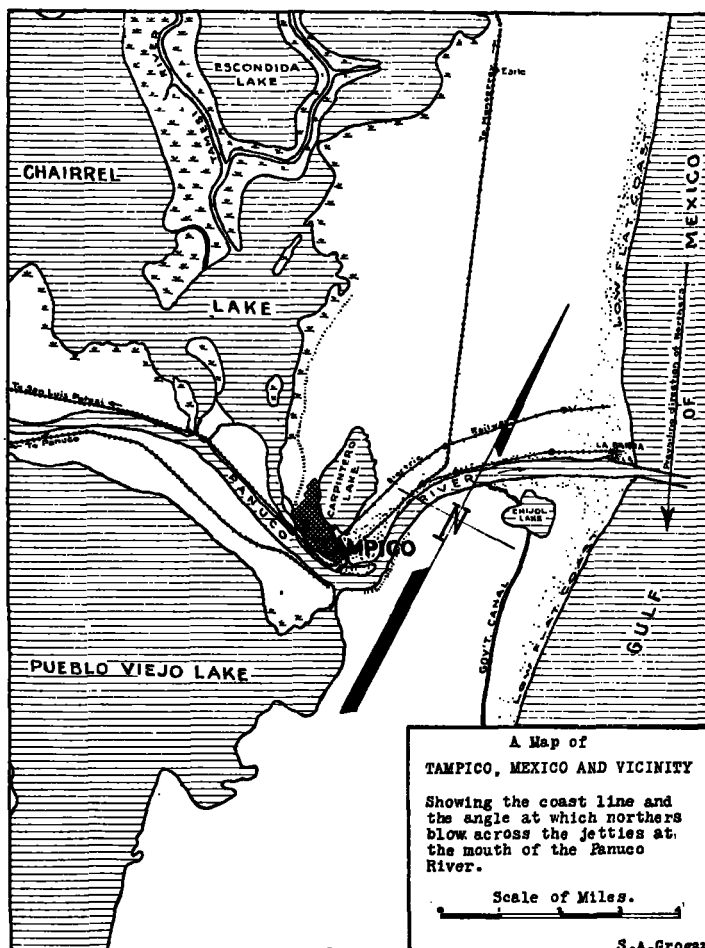


FIG. 1.

On January 22, 1919, the tug *George* left port late in the afternoon with a barge of oil to be taken outside the bar. A norther was blowing at the time, and although the out-

ward trip was made without mishap, upon its return the boat was thrown out of the channel and upon the south breakwater. Thirteen lives were lost in that accident, among whom were the two pilots, and the tug was a complete loss.

Probably the hardest norther of the winter of 1918-19 blew during the afternoon and night of February 26, 1919. Although we had no anemometer to determine the velocity, it was probably about 50 miles per hour. It was strong enough to blow down fences, remove sheet-iron roofs and to make walking in the street very difficult. No damage was done to shipping in the vicinity of Tampico, but several losses were reported among the sailing vessels of the fishermen near Vera Cruz.

The greater part of the losses on the Tampico breakwater have probably been due to poor judgment on the part of the captains or to their ignorance of the conditions which exist at that place during a norther.

Figure 1 shows a map of Tampico and vicinity, and by consulting this it may be seen that the Panuco River empties into the Gulf of Mexico in an east-northeastern direction. The prevailing direction of the northers in this vicinity is from the north-northwest, or at right angles to the direction of the flow of the river. For that reason the difficulty in passing through the jetties when a norther is blowing is easily realized. The breakwater was begun a short time before the revolution and was never completed. Both the outer points are completely submerged and other places further in have been damaged by the high seas. Most ships lie outside or in port when a norther is blowing and enter or leave after the danger has passed.

In October, 1917, the Mexican Gulf Oil Co. at Tampico, began to make observations, under the supervision of the writer, in order to ascertain if there was any way of being forewarned of the northers along this coast. A barograph, thermograph, maximum, minimum, wet and dry-bulb thermometers, as well as a common raingauge, were provided.

After a careful study of the northers during the past two winters and the conditions which prevail in advance of their coming, I feel assured that a fair degree of accuracy has been and can be made in forecasting northers from local observations at this place. Of course no set time can be made for their coming, but they have been forecast within from 12 to 24 hours. From September, 1918, to June, 1919, as stated above, 31 northers blew at Tampico, and of those 18 were forecast either at 8 a. m. on the morning before or during the day before. As may be seen from the above figures, 13 northers came without their approach being detected from the observations made. Also at other times northers were predicted when it was believed that favorable conditions prevailed for one, and none came.

The northers during the winter of 1918-19 were distributed by months, as follows: 1918—September, 1 (light); October, 2; November, 4; December, 3. 1919—January, 4; February, 8; March, 4; April, 3; May, 1 (light); June, 1 (very light).

The general weather conditions which prevail preceding a norther in this vicinity can best be shown by a description and a meteorogram of the weather which preceded a typical norther.

Table 1 gives in detail the observations made by me on October 26 and 27, 1918:

TABLE 1.—Weather observations, Tampico, Mexico, Oct. 26 and 27, 1918.

| Observation of— | Tampico time. | | | |
|--------------------------|---------------|---------------|---------------|---------------|
| | Oct. 26. | | Oct. 27. | |
| | 6:30 a. m. | 6:30 p. m. | 6:30 a. m. | 6:30 p. m. |
| Dry thermometer..... | 78° F..... | 81° F..... | 65° F..... | 71° F. |
| Wet thermometer..... | 77° F..... | 79° F..... | 54° F..... | 58° F. |
| Dew point..... | 77° F..... | 78° F..... | 45° F..... | 48° F. |
| Relative humidity..... | 96 per cent. | 92 per cent. | 48 per cent. | 45 per cent. |
| Vapor pressure..... | 0.926 inch. | 0.957 inch. | 0.298 inch. | 0.334 inch. |
| Barometer..... | 29.72 inches. | 29.66 inches. | 29.98 inches. | 30.01 inches. |
| Maximum temperature..... | 80° F..... | 92° F..... | 81° F..... | 74° F. |
| Minimum temperature..... | 77° F..... | 78° F..... | 64° F..... | 65° F. |
| Maximum pressure..... | 29.84 inches. | 29.73 inches. | 29.98 inches. | 30.04 inches. |
| Minimum pressure..... | 29.70 inches. | 29.62 inches. | 29.66 inches. | 29.98 inches. |
| State of weather..... | Cloudy..... | Part cloudy. | Cloudy..... | Cloudy. |
| Wind from..... | S..... | E..... | N..... | N. |
| Precipitation..... | 0.02 inch. | None..... | 0.02 inch. | None. |

During the 24-hour period ending at 6:30 a. m. on October 26, 1918, the air pressure reached a minimum of 29.70 inches during the afternoon of the 25th, and with the exception of the slight diurnal rise in the fore part of the night, there had been very little change up to that hour. The wind was from the south; it was cloudy, the temperature 78° F., and the relative humidity 96 per cent. During the day of the 26th the pressure continued to drop until it reached 29.62 inches at 3:30 p. m., the wind had changed to the east and a maximum temperature of 92° F. was recorded at 2 p. m. At 6:30

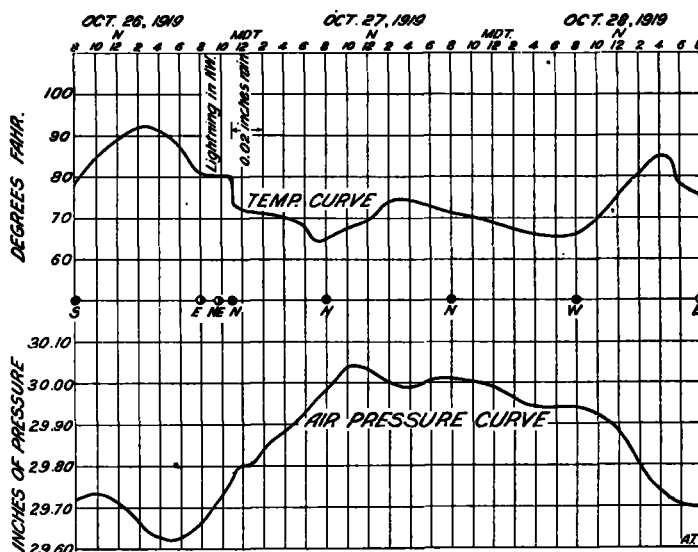


FIG. 2.

p. m. the wind was still from the east, the temperature 81° F., relative humidity 92 per cent, and the sky was partly cloudy. As soon as darkness had come, lightning was observed in the north and northwest. At 8 p. m. the cloud was in plain view in the northwest and the electrical display was vivid. Since 3:30 p. m. the air pressure had been rising and at that hour had reached 29.71 inches. At 9:30 p. m. the storm struck with a light precipitation of 0.02 inch, and was followed by a stiff north wind.* This norther was forecast at 8 a. m., October 26, to come within the next 24 hours, as near as could be judged. A study of the weather map for 8

* The front of this norther was similarly well-defined in Texas.—C. F. B

a. m. on that date reveals the actual conditions as existed in the western part of the United States.

Figure 2 shows the tracings from the thermograph, corrected to the thermometer readings, and from the barograph here, from 8 a. m. (seventy-fifth meridian time), October 26 to 8 p. m., October 28, 1918.

The norther, given as an example, came in the early part of the night, but the greater part of them come from 2 to 4 a. m. However, the phenomena preceding this one is typical and the description of the weather preceding a typical norther in this vicinity can be expressed in the following general terms:

There is a very low air pressure during the afternoon before (usually about 29.60 inches) after which it begins to rise gradually until the norther begins to blow, there is a high maximum temperature, high relative humidity, very often a heavy dew in the first part of the night, at times a fog on the morning before, the wind backs from south to northeast and lightning is generally to be seen in the northwest. The first part of the blow is usually accompanied by a light rainfall and there is a

general cloudiness throughout the entire time the norther blows.

The northers are not always typical, but at times blow up when there has been no warning by the air pressure and the other phenomena, as given in the example, and very often they repeat within a few hours' time.

It can be seen that the only method that can be used in making a forecast of a norther in this vicinity is from a comparison of the conditions at any time with those which occurred before a typical norther came, and if the conditions are similar the probability of a norther is very good, as I have found.

The writer feels that until some better means of knowing the coming weather can be provided for Tampico and the east coast of Mexico, our efforts are not in vain. On several occasions light craft have been held in the port by being warned that a norther was very likely to blow within the next 24 hours. The captain of the port of Tampico, wired our daily reports to Vera Cruz during the winter months and words of appreciation have been received from that important port.

FOG IN CENTRAL OHIO AND ITS RELATION TO SUBSEQUENT WEATHER CHANGES.

By HOWARD H. MARTIN, Observer.

[Dated Weather Bureau Office, Columbus, Ohio, May 26, 1919.]

Fog is a meteorological phenomenon. It is the direct result of the depression of the air temperature to a point equal to or lower than the existing dew point. This depression may be brought about by radiation and conduction, cooling by atmospheric expansion, or by the mixing of cold and warm, humid air. Fogs due to radiation occur for the most part over valleys and low ground after a warm afternoon. Those due to cooling by expansion are rarely local, but may cover relatively vast areas. Inland fogs due to mixing usually occur at or near the wind-shift line during the passage of a cyclonic area. Such fogs are uncommon in Ohio, and when they do occur, usually precede a rapid and severe drop in temperature.

All fogs may be classified into (1) radiation fogs, those fogs due to radiation in quiet air and (2) advection fogs, those general fogs due to cooling by conduction, radiation, mixing or expansion in horizontally-moving air. Radiation fogs occur for the most part during the late spring and summer months, are very local and without apparent significance. Advection fogs, being due to air movements, often are indicative of weather changes. These fogs occur during the winter and the early spring months, usually with clouds, and precede a marked rise or fall in pressure by from 6 to 30 hours. It is well to discriminate here, though not in the general classification, between the fogs near or in low pressure centers or troughs, and the fogs immediately in the rear of an anticyclone. The former occur practically at the center of the disturbance, during a temporary lull in the wind, and, of course, are dissipated by the colder, drier winds from the west; the latter often occur during the prevalence of high pressure and appear to be the first symptom, if such a term is permissible here, of an immediate decrease in atmospheric pressure. Of 44 dense fogs recorded under these conditions, 38, or 86 per cent, were followed immediately by decreasing pressure (within 12 hours) and 92 per cent, by falling barometer within 24 hours.

The records of the Weather Bureau Office at Columbus (Ohio) show that from 1900-1918, inclusive, 144 dense fogs occurred. Previous to a study of these fogs, the writer had given considerable attention to the relation of fogs to weather changes in northeast Texas, and the results are comparable, bearing out, to a large degree, the significance of the phenomenon in connection with subsequent precipitation.

It has been found that at Columbus, Ohio, during the months of December, January and February, 1900-1918, dense fogs occurred on 76 days, the average duration in each case being 3.8 hours. Of these, 43 per cent occurred during precipitation; 67 per cent preceded rain or snow by 24 hours or less; 83 per cent by 36 hours or less; and 90 per cent by rain or snow within 48 hours. Of the entire number observed during these months, 92 per cent were followed within 24 to 30 hours by a marked pressure change, and of these changes, 69 per cent were falls, 19 per cent increases, 10 per cent falls followed by rises and 2 per cent by rises followed by falls.

During the months of March, April, and May, 22 dense fogs occurred, with an average duration of 2.7 hours, and of these 29 per cent occurred during precipitation, 40 per cent preceded rain or snow by 24 hours or less; 76 per cent within 36 hours, and 80 per cent within 48 hours. Of these 22 fogs, 76 per cent were followed by marked pressure changes within 24 hours, of which 59 per cent were falls, and 41 per cent rises.

During the summer months, the few dense fogs on record, total 5, were all radiation fogs, and hence had no apparent significance with relation to coming changes.

During the months of September, October, and November, 41 dense fogs were recorded, with an average duration of 4.2 hours. Of these, 17 per cent occurred during precipitation, 39 per cent were followed by rain or snow within 24 hours, 53 per cent within 36 hours, and 66 per cent within 48 hours. Of the number recorded, 63 per cent were followed by marked pressure changes, of